PERFORMANCE OF GRASSES, SHRUBS AND TREES ON DISTURBED SOIL AT THE AOSERP MILDRED LAKE CAMP EXPERIMENTAL AREA

(File Report)

by

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for

ALBERTA OIL SANDS

ENVIRONMENTAL RESEARCH PROGRAM

LS 7.5

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DISCLAIMER

The authors stress that this report was not prepared for external publication. In our opinions the data is not strong enough to warrant an attempt to make it into a publication. The report was written to provide some guidance regarding the future of the experimental material at the AOSERP Mildred Lake Camp. We hope we have achieved our goal.

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ABSTRACT

The plants referred to in this report were initially established on the AOSERP Mildred Lake Camp area in 1977. The objectives of the program were to establish grass, shrub and tree species for evaluation of their response, particularly their reproduction response, to the climatic and edaphic conditions north of Fort McMurray. Over the 1977 growing season, 50 species and/or sources of grasses were spring seeded, 47 species and/or sources were started in containers and transplanted to the field and 24 species and/or sources were fall seeded. In addition, 12 woody plant species and/or sources were also planted in the field after growth in the greenhouse in containers. This report discusses the results of an evaluation of the plants conducted in late August and September, 1979.

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ACKNOWLEDGEMENTS

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1. INTRODUCTION

It generally has been the practice to use agricultural varieties of grasses and legumes in revegetation efforts on disturbed sites in Alberta (Vaartnou and Sons Enterprises Ltd. 1977). The agronomic varieties of grasses and legumes provide a reasonably stable ground cover under optimal conditions, but can be far less successful in revegetating sites where conditions are less favourable.

A number of native species which have been found useful for vegetation in regions similar to northern Alberta may also be suitable for reclamation in the oil sands. For example, the following taxa may be useful: Deschampsia beringensis from Alaska (Mitchell 1973); Agropyron scribneri and Poa fendleriana from alpine tundra of Colorado (Greller 1974); Festuca rubra and Agrostis stolonifera from strip-mined areas in the eastern U.S.A. (Bennett 1973); and Agropyron trachycaulum and Festuca rubra from tailings areas in the Yukon (Bayne 1975).

With native grasses and legumes there is always the question of seed availability on a commercial basis. This need not be an obstacle, for if there is a market, it can be done. For example, three native species prevalent in northern and central Canada (Arctagrostis latifolia, Calamagrostis canadensis and Festuca rubra), are being grown commercially in Alaska for pipeline revegetation (Mitchell 1972) along with several genera of grasses including Agropyron, Bromus, Elymus, Festuca, and Poa. Several species of this genera are also being tested in the present AOSERP revegetation program

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for capacity to revegetate tailings sand and other substances requiring recolonization in the oil sand area.

Use of nitrogen-fixing species as part of a revegetation program can help to ensure a continuing supply of nitrogen (Berg 1976). Some of the native genera of nitrogen-fixing plants are Alnus, Shepherdia, Dryas, and Elaeagnus. These genera are characteristic pioneers in areas low in available nitrogen (Stewart 1967).

In response to a number of unknowns regarding native species, a revegetation research program was initiated in 1973 by Alberta Agriculture. The objective was to determine native species suitable for revegetation along roadsides, pipeline and powerline rights-of-way, mining sites and on problem soil types throughout Alberta (Wheeler and Vaartnou 1974). This program was expanded to include the Athabasca oil sands in 1975 with the beginning of the Alberta Oil Sands Environmental Research Program (AOSERP). Dr. H. Vaartnou served as the principal coordinator of the joint project. In 1977, the AOSERP portion of the project was separated from Alberta Agriculture's program.

The objectives of the AOSERP segment of the program have been to increase the state of knowledge concerning species selection, seed production, and techniques for revegetating the disturbed oil sands areas of the Fort McMurray area in northern Alberta.

In mid-summer of 1976, a decision was made to establish a portion of this study in the Fort McMurray area and establishment was completed in 1977.

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The details regarding study design, species used and other items are provided by Vaartnou and Sons Enterprises Ltd. (1978). Information obtained in 1975 is presented in Vaartnou (1976) and 1976 results are discussed in Vaartnou and Sons Enterprises Ltd. (1977).

No evaluations were made in 1977 or 1978 of the material established in 1977 at Fort McMurray and early in 1979 part of the study plot was destroyed.

A decision was made within the provincial government to sacrifice part of the native grass experimental area for establishment of an AOSERP LS7.1 Tree and Shrub Uniformity Garden. Approximately 65 percent of the original grass testing site was eliminated.

Since no previous evaluation had been conducted, a decision was made to evaluate the remaining species in terms of their performance through 1979. This was done to salvage species information for possible future research work. This report presents the results of the evaluation of the remaining test material in late August and September, 1979.

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2. STUDY AREA

The LS 7.5 project site is located on the southeast corner of the cleared area adjacent to the AOSERP Mildred Lake Research Facilities (Figure 1) on oil sand lease 17 (NE ¼, S18, T93, R18). This station is situated at an elevation of 314 m above sea level in the Boreal Forest Region (Rowe 1972) and Grey Luvisolic soil zone of Alberta (Lindsay et al. 1962). The site is sandy throughout the depth of the soil profile. This well-drained, sandy site formerly had open stands of Pinus banksiana and Populus tremuloides with a closed ground cover of lichens and shrubs dominated by Arctostaphylus uva-ursi (Vaartnou and Sons Enterprises Ltd. 1977).

Climatically, the region is cool, temperate, with long, cold winters and short summers, often with only brief periods of 24^{0}C and above. There is extended daylight during June and July with a growing season of about 95 days from May through August. The total annual precipitation averages 43 cm with 28 cm recorded as rainfall (Longley and Janz 1978).

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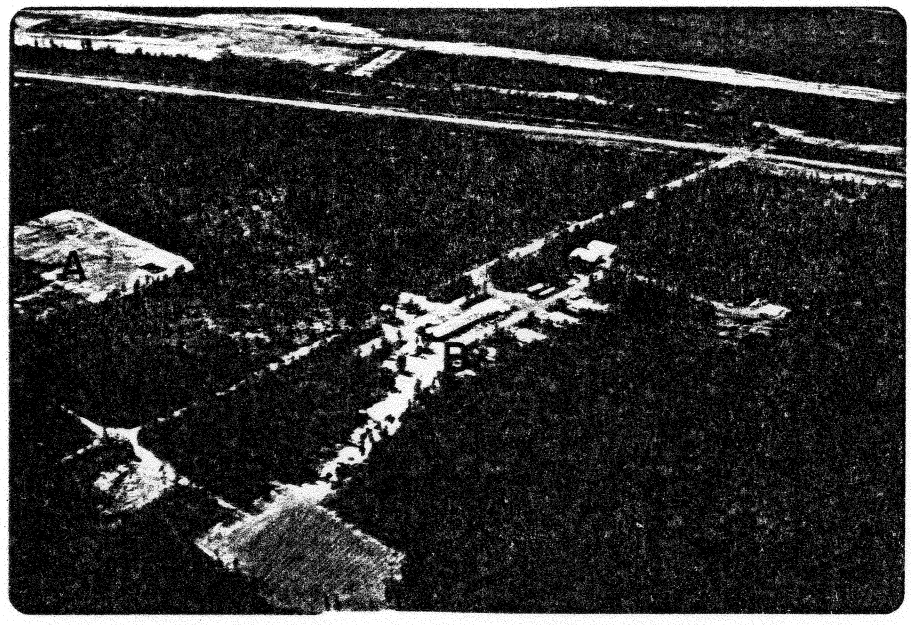

FIGURE 1: An Aerial View Showing the AOSERP Mildred Lake Facility (B) in the Center and the Study Area (A) to the Left of Center.

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3. METHOD AND MATERIALS

No suitable sites were available in the Fort McMurray area so a site was selected, cleared, prepared and the various grass and woody plants to be established on the plots were selected. These items are discussed in the following paragraphs.

3.1 Site Preparation

A two hectare area immediately adjacent to the AOSERP camp north of Fort McMurray was cleared of vegetation and debris and disked during the summer of 1976 (Figure 2). The area was mainly prepared as a nursery plot to evaluate seed production and make general observations about the establishment of various grasses, shrubs and trees under Fort McMurray conditions (Figure 3). For further details on plot design and layout, see Vaartnou and Sons Enterprises Ltd. (1978).

3.2 Species

The plants selected for seeding on the Fort McMurray site were those native species which had performed satisfactorily during the early stages of the study (Dr. H. Vaartnou, Vaartnou and Sons Enterprises Ltd., personal communication). Some of the specific characteristics selected for were: 1) aggressiveness, 2) extensive root system development, 3) adaptability to specific edaphic factors, 4) rapid growth, and 5) excellent natural reproduction, either vegetatively or sexually.

Species of grasses, shrubs and trees assessed are presented in Table 1. Species were placed on the site in three different phases. Included were:

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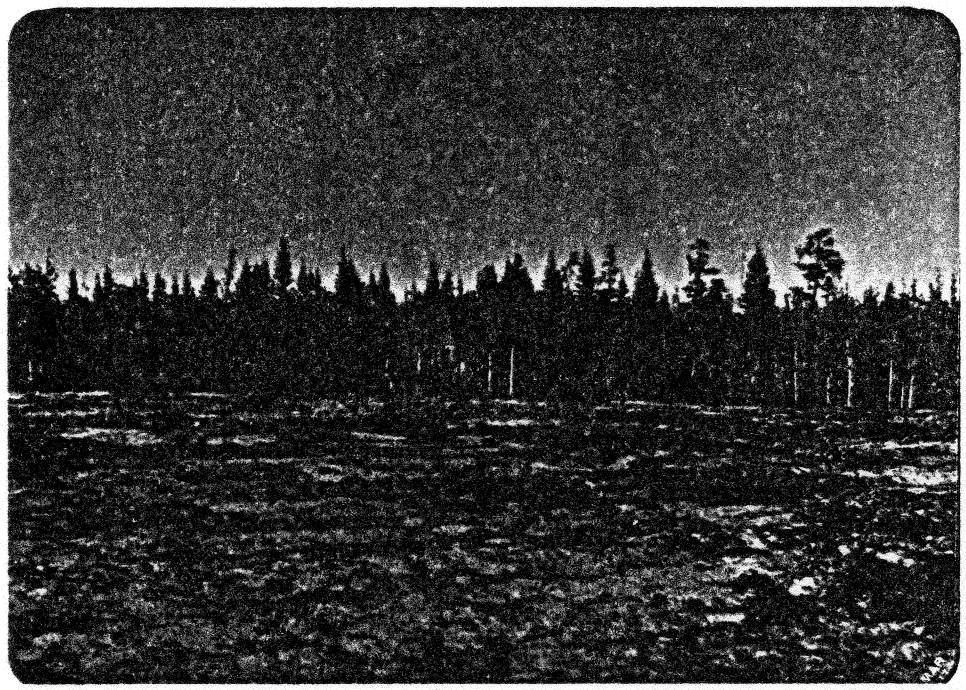

FIGURE 2: Preparation of Test Site Near AOSERP Camp.

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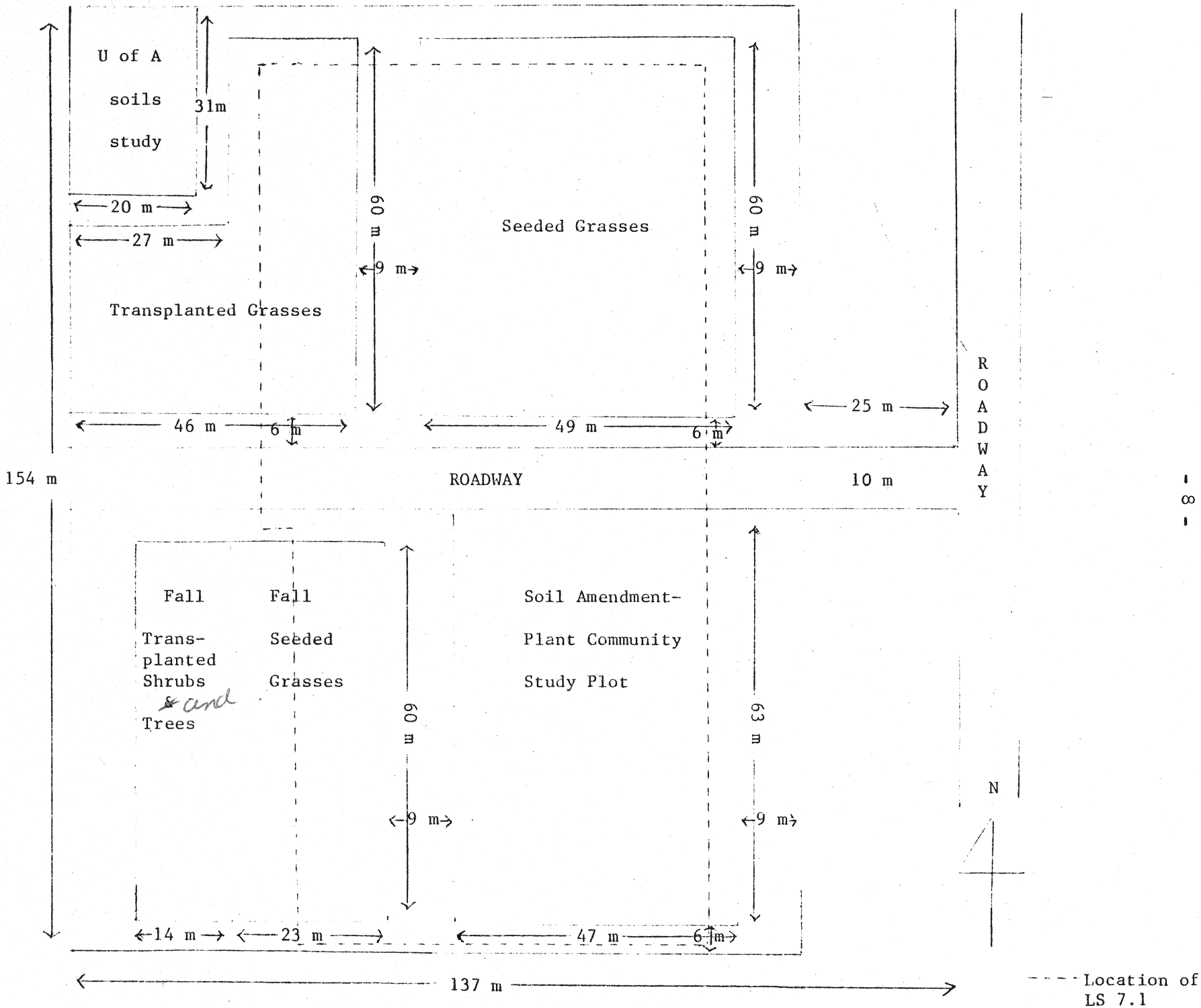

Figure 3. AOSERP, Mildred Lake Revegetation Test Site Diagram

1) direct seeding in the spring, 2) direct seeding in the fall, and 3) transplanting of plants grown elsewhere in containers. Shrubs and trees were grown in containers in Alberta Agriculture greenhouses in Edmonton, Alberta. They were transplanted on the site in fall, 1977 (Figure 3).

3.21 Spring Seeded Grasses

Fifty rows of a variety of grass species were seeded (Table 1) using a hand-pushed seeder. The rows were 60 m long and spaced one m apart. The species were seeded one to a 60 m row in late May, 1977 without replication. No fertilizer was or has since been applied and no irrigation was used.

3.22 Transplanted Grasses

Forty-seven rows of grasses were transplanted in late June to early July, 1977. All grass plants were grown in Spencer-Lemair "Ferdinand" containers in the greenhouse during the spring of 1977. Plants were hardened outside of the greenhouse in Edmonton before being transplanted.

In planting, each containerized grass plant was removed from the container just prior to being planted in the field. Seedlings were planted one species to a row (Table 1) at 60 cm apart in rows that were 60 m long and with one m between rows. Water and fertilizer were not and have not been used on the transplants.

3.23 Fall Seeded Grasses

Twenty-four rows of grasses (Table 1) were seeded in rows that were 60 m long and with one m between rows (one row of each species) in September 1977. The methods used were as described in section 3.21.

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TABLE 1: Species used in the experiment at Fort McMurray

SCIENTIFIC NAME	COMMON NAME	STOCK NO.	
Grasses			
Agropyron cristatum	Crested wheat grass	244	(a) (S)
" "	"	464	(b) (T)
Agropyron elongatum	Tall wheat grass	465	(T)
Agropyron repens	Couch grass	1	(S)
Agropyron smithii	Western wheat grass	46	(T)
" "	"	47	(S)
" "	"	261	(S)
" "	"	342	(S)
" "	"	471	(T)
Agropyron spicatum	Bluebunch wheat grass	656	(T)
Agropyron subsecundum	Bearded wheat grass	4	(S)
" "	"	658	(T)
" "	"	659	(T)
Agropyron trachycaulum	Slender wheat grass	10	(S)
" "	"	246	(S)
" "	"	286	(S)
" "	"	660	(T)
" "	"	662	(T)
Agropyron spp.	Wheat grass	41	(S)
" "	"	54	(S)
" "	"	55	(S)
" "	"	333	(S)
" "	"	338	(S)
" "	"	483	(S)
" "	"	592	(S)
" "	"	655	(T)
Agrostis gigantea	Red top	59	(S)
" "	"	269	(T)
Agrostis scabra	Tickle grass	664	(T)
Agrostis tenuis	Colonial bent grass	282	(T)

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Agrostis tenuis	Colonial bent grass	297	(T)
" "	"	329	(T)
Agrostis spp.	Bent grass	15	(T)
" "	"	665	(T)
" "	"	765	(T)
Alopecurus ventricosus	Creeping foxtail	97	(S)
Alopecurus spp.	Water foxtail	18	(S)
Arctagrostis spp.	Polar grass	666	(T)
"	"	667	(T)
Beckmania syzigachne	Slough grass	355	(T)
" "	"	498	(T)
Bouteloua gracilis	Blue gramma	668	(T)
" "	"	669	(T)
Bromus inermis	Smooth brome grass	61	(S)
" "	"	62	(S)
" "	"	263	(S)
Bromus pumpellianus	Northern awnless brome	64	(S)
" "	"	346	(S)
Calamagrostis spp.	Reed grass	671	(T)
Cinna latifolia	Slender wood grass	675	(T)
Deschampsia caespitosa	Tufted hair grass	677	(T)
Deschampsia spp.	Hair grass	66	(S)
" "	"	67	(S)
" "	"	680	(T)
Danthonia parryi	Parry oat grass	767	(T)
Elymus canadensis	Canada wild rye	20	(S)
Elymus innovatus	Hairly wild rye	294	(S)
" "	"	331	(S)
Elymus spp.	Wild rye	73	(S)
Festuca altaica	Fescue grass	75	(S)
Festuca ovina	Sheep fescue	21	(S)
Festuca rubra	Red fescue	22	(S)
" "	"	76	(S)
Festuca scabrella	Rough fescue	26	(S)
" "	"	688	(S)

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Festuca saximontana	Saximontana fescue	526	(S)
" "	" "	686	(S)
" "	" "	1182	(S)
Festuca spp.	Fescue	77	(S)
Glyceria spp.	Manna grass	691	(T)
" "	"	692	(T)
Koerelia cristata	June grass	78	(T)
" "	"	1148	(S)
Phalaris arundinacea	Reed canary grass	696	(T)
Phleum pratense	Timothy	239	(S)
Phleum spp.	Timothy	81	(T)
" "	"	336	(S)
Poa alpina	Alpine blue grass	83	(S)
Poa ampla	Big blue grass	36	(S)
" "	"	85	(S)
" "	"	86	(S)
Poa compressa	Canada blue grass	37	(S)
Poa glaucantha	Blue grass	202	(S)
Poa palustris	Fowl blue grass	89	(S)
" "	"	628	(T)
Poa pratensis	Kentucky blue grass	38	(S)
" "	"	40	(S)
" "	"	92	(S)
" "	"	101	(S)
" "	"	265	(S)
" "	"	305	(S)
" "	"	697	(T)
Poa spp.	Blue grass	93	(S)
" "	"	94	(S)
" "	"	95	(S)
" "	"	698	(T)
" "	"	700	(T)
" "	"	701	(T)
" "	"	769	(T)
" "	"	Unknown	(S)
" "	"	"	(T)

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Puccinellia nuttalliana	Nuttal's alkali grass	276	(S)
" "	"	703	(T)
" "	"	705	(T)
Puccinellia spp.	Alkali grass	43	(S)
Stipa comata	Spear grass	713	(T)
Stipa virudura	Green needle grass	554	(T)
Trisetum spicatum	Spike trisetum	407	(T)
Shrubs and Trees			
Alnus spp.	Alder	557	(T)
" "	"	558	(T)
Betula glandulosa	Dwarf birch	G.C.O.S.	(T)
Elaeagnus commutata	Silver berry	134	(T)
" "	"	135	(T)
Larix siberica	Siberian larch	O.P.T.N.	(T)
Pinus contorta	Lodgepole pine	O.P.T.N.	(T)
Potentilla fruticosa	Shrubby cinquefoil	139	(T)
" "	"	141	(T)
Prunus virginiana	Chokecherry	144	(T)
Shepherdia argentea	Thorny buffaro berry	184	(T)
Shepherdia canadensis	Canadian buffaro berry	186	(T)

(a) Seeded

(b) Transplant

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3.24 Shrubs and Trees

The shrubs and trees (Table 1) were started and grown in Spencer-LeMaire "Rootrainers" in the greenhouse in Edmonton for one year before being transplanted into the field plots.

There were fourteen rows of shrubs and trees transplanted in September, 1977. These plants were put in 60 m rows with one m between rows. The plants were planted one m apart within the rows.

3.3 Evaluation of Performance

Measurement of several parameters, vigor, disease and standing crops, was deleted from the 1979 evaluation. The phenologically appropriate time for assessing these parameters was before the evaluation was made. Also, for determination of the standing crop, the dead material should be cleared early in the year to alleviate the time consuming job of separating previous year's growth from that of the year in question.

The lateness of the evaluation and a desire to have seed in stock for preservation of genetic stock dictated that seed be collected before any other evaluation. As it was, the seed was already gone from some species.

The ripe seed heads were severed from the stocks using hand clippers and subsequently were placed into cotton bags and appropriately tagged. The majority of the species, 97 out of 107, had produced seeds. The seed collection was carried out from August 22 to 23 and in early September 1979 and is currently

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being stored at the Alberta Environmental Centre in Vegreville.

The assessment procedures have been tailored for the three types of material present on the area; seeded grasses, transplanted grasses and woody plants. The methodology used is out-lined in the succeeding paragraphs.

3.31 Seeded Grasses

For this group of grasses it was impossible to separate the individual plants from one another and thus the following sampling procedure and parameters were utilized:

1. Take 3 plots, 20.4 cm x 73.4 cm (= o.15 m^2), in the first 4.5 meters of each seeded row regardless if it is a long or short row. Start with the first plot one meter in from the outside edge of the experimental area, and then take one every 1.5 m from the first plot point.
2. Within each plot determine:
   a) Collect seed from all of the short row length and at least a similar amount from the long rows. All seed will be collected, labelled with stock no., species and collection date for later storage and cleaning at the Vegreville Alberta Environmental Centre. The seed collection will be done first because of the lateness of the season.
   b) Percent Cover Class
      1 = 0 - 3% cover
      2 = 3 - 10% cover
      3 = 10 -25% cover
      4 = 25 -50% cover
      5 = 50 -75% cover
      6 = 75 -100% cover

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c) Seed Production and Heading

i) Headed = Y = Yes: N = no
ii) Seed Production
class 1 = 0 (no heads)
2 = ≤10 (few)
3 = 10 - 30
4 = 30 - 50
5 = 50 + (many)

d) Height (modal class) of leafy growth, excluding seed heads, as determined by 5 cm class (vertical plot profile board).

e) For rhizomatous varieties measure the average spread (cms.) from the two longitudinal (73.4 cm.) perimeters of the plot frame outward.

3. For each of the long seeded rows do an additional 10 plots in each row according to procedures in Item 2, a to e. Place one plot every five meters after the first five meters from the outside (wooded) end of the row. For those rows which are shorter than 60 meters adjust the spacing to permit placing 10 plots in the material present. Note the row and adjustment.

3.32 Transplanted Grasses

The same parameters were measured as in Section 3.31, but there were a few exceptions in the methodology as it was possible in this situation to sample individual plants.

The methodology exceptions used were:

1. For each row (short or long) out of the first 10 transplants sample every other plant starting with the second plant in (5 "plots"). Plot size here should be 50 cm x 50 cm (= 0.25 m^2). Do steps a to e in Section 3.31 for these plants.

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2. For the long transplant rows do steps a to e, Section 3.31, starting with plant number 20 in from the outside edge. Do 15 plants, checking every fifth plant.

3.33 Woody Plants

By necessity the tree and shrub parameters were different from those used to assess the grasses. The method used and parameters measured are given below:

1. Do 15 plants in each long row, starting with number three from the outside edge and do every third plant. For the short rows do each plant. Survey and note the following for each plant:

   a) alive or dead (percent survival)

   b) height of longest leader (cm.)

   c) crown diameter (2 measurements, cm.)

   d) flowering, fruiting (yes or no)

2. Assign a vigor class to living individuals using the following criteria:

   For each symptom noted below subtract 1 from the initial value of 4:

   a) stem dieback and/or frost cracks (winter injury)

   b) chlorotic foliage and/or scorched or mottled leaves and leaf margins (nutrient deficiencies/toxicities)

   c) leaf defoliation or skeletonization and/or stem lesions, cankers, galls, etc. (insects and disease damage)

   d) poor current growth and form (relative to the species)

   class 1 = poor ($\leq$ 1)
   2 = fair (2)
   3 = good (3)
   4 = excellent (4)

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4. RESULTS AND DISCUSSION

The assessment procedures were designed for three types of materials: seeded grasses, transplanted grasses and woody plants. In this section the first group, seeded grasses, is further sub-divided into spring and fall seeded grasses. Discussion is focused on the various assessed parameters in each of the four resulting groups.

4.1 Spring Seeded Grasses

Two seed sources, Bromus pumpellianus (346) and Poa pratensis (40), completely failed to survive (Table 2). The most successful grasses in terms of plant cover, using 50 percent as the criterion for success, were Agropyron spp. (592), Elymus innovatus (294 and 331), Deschampsia spp. (66 and 67), Festuca rubra (76), Festuca ovina (21), Festuca scabrella (688), Phleum pratense (239), Poa ampla (85), Poa pratensis (305) and Poa spp. (93, 94 and 95). All of these species also produced more than 50 seed heads per plot (Table 2).

The average height of the vegetative growth of the species in this group ranged from 24 to 62 cm. The taller grasses being Elymus innovatus (294, 331) and Agropyron spp. The shortest grasses were in the Poa, Festuca and Deschampsia genera.

The amount of cover produced by Alopecurus ventricosus (97), Festuca saximontana (686) and Koeleria cristata (1148) was less than 10 percent, very poor compared to the other species.

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TABLE 2: Average vegetative cover, plant height, spread and seed production of seeded grasses at Fort McMurray as determined in fall, 1979

(a) Row No.	Species	Stock No.	(b) Percent cover class	Average height (cm)	Average rhizomatous spread (cm)	(c) Seed Production Class
1	Agropyron spp.	592	5	55	0	5
2	Agropyron cristatum	244	4	76	0	5
3	Agropyron repens	1	(d)-	-	-	-
4	Agropyron smithii	47	4	47	0	5
5	Agropyron smithii	261	3	33	9	2
6	Agropyron spp.	54	4	83	0	5
7	Agropyron spp.	338	4	85	0	5
8	Agropyron spp.	333	3	75	0	5
9	Agropyron spp.	483	4	58	0	5
10	Agropyron subsecundum	4	3	52	0	3
11	Agropyron trachycaulum	246	4	72	0	5
12	Alopecurus ventricosus	97	2	87	11	3 Not Matured
13	Alopecurus spp.	18	3	88	0	2
14	Bromus inermis	62	3	60	0	2
15	Bromus inermis	61	4	57	8	4
16	Bromus pumpellianus	64	3	68	8	3
17	Bromus inermis	263	3	67	10	2
18	Bromus pumpellianus	346	No survival			
19	Elymus innovatus	294	5	62	6	5
20	Elymus innovatus	331	5	62	6	5
21	Elymus spp.	73	3	72	2	3
22	Elymus canadensis	20	3	58	0	3
23	Deschampsia spp.	66	6	33	0	5
24	Deschampsia spp.	67	6	33	0	5
25	Festuca rubra	76	5	37	0	5
26	Festuca ovina	21	5	35	2	5
27	Festuca saximontana	526	3	23	0	4
28	Festuca spp.	77	4	40	0	4
29	Festuca scabrella	26	4	42	0	5

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30	Festuca saximontana	1182	4	35	0	5
31	Festuca saximontana	686	1	10	0	2
32	Festuca scabrella	688	5	47	0	5
33	Koeleria cristata	1148	1	20	0	2
34	Phleum pratense	239	6	45	0	5
35	Phleum spp.	336	4	38	4	5
36	Poa compressa	37	3	35	5	4
37	Poa ampla	86	3	33	0	5
38	Poa pratensis	40	No survival			
39	Poa alpina	33	3	23	0	2
40	Poa ampla	85	5	26	0	5
41	Poa palustris	89	4	37	0	5
42	Poa ampla	36	4	35	0	5
43	Poa spp.	95	5	33	0	5
44	Poa spp.	93	5	44	0	5
45	Poa spp.	94	5	24	0	5
46	Poa pratensis	101	4	17	0	4
47	Poa pratensis	265	4	21	0	4
48	Poa pratensis	305	5	31	2	5
49	Poa glaucantha	202	3	28	0	3
50	Puccinellia spp.	43	-	-	-	-

(a) Sample Plot Size 20.4 cm x 73.4 cm (= 0.15 m^2)
Row 1 - 5 : 13 Sample Plots (long rows)
Row 6 - 50: 3 Sample Plots (short rows)

(b) Percent Cover Class

1 = 0 - 3%
2 = 3 - 10%
3 = 10 - 25%
4 = 25 - 50%
5 = 50 - 75%
6 = 75 - 100% cover

(c) Seed Production Class

1 = 0 No heads on plot
2 = $\leq$ 10 (few)
3 = 10 - 30
4 = 30 - 50
5 = 50 + (many)

(d) No data collected

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Some grasses reproduced vigorously by rhizomes, but produced very few seed heads. This was true for Agropyron smithii (261) (Figure 4), Bromus inermis (62 and 263) and Bromus pumperianus (64) (Figure 5). Elymus innovatus (294 and 331), however, was an exception and produced many seed heads as well as exhibiting a relatively high rate of spread.

In general, all the surviving species matured sufficiently to produce some seed heads except for Alopecurus ventricosus (97). This species failed to mature.

The average number of seed heads recorded per plot was 30. It should be noted that the number of seed heads produced was very few for Agropyron smithii (261), Alopecurus spp. (18), Bromus inermis (263), Festuca saximontana (686) and Poa alpina (83).

4.2 Transplanted Grasses

Survival of transplanted grasses was generally low (Table 3). Six of the initial 47 species failed to survive. The rather poor establishment rate of Fort McMurray may have been due to the time of transplanting. However, some Agrostis genera and Poa genera did show good growth and produced relatively high numbers of seed heads (Table 3). There was also a moderate increase in the number of rhizomes produced by Agrostis species. Some indication of the appearance of the plants in terms of growth are shown in Figure 6.

Agropyron smithii (471) failed to reach maturity in 1979. Bouteloua gracilis (668 and 669) matured later than other species and may not have reached maturity if the growing season had been slightly shorter.

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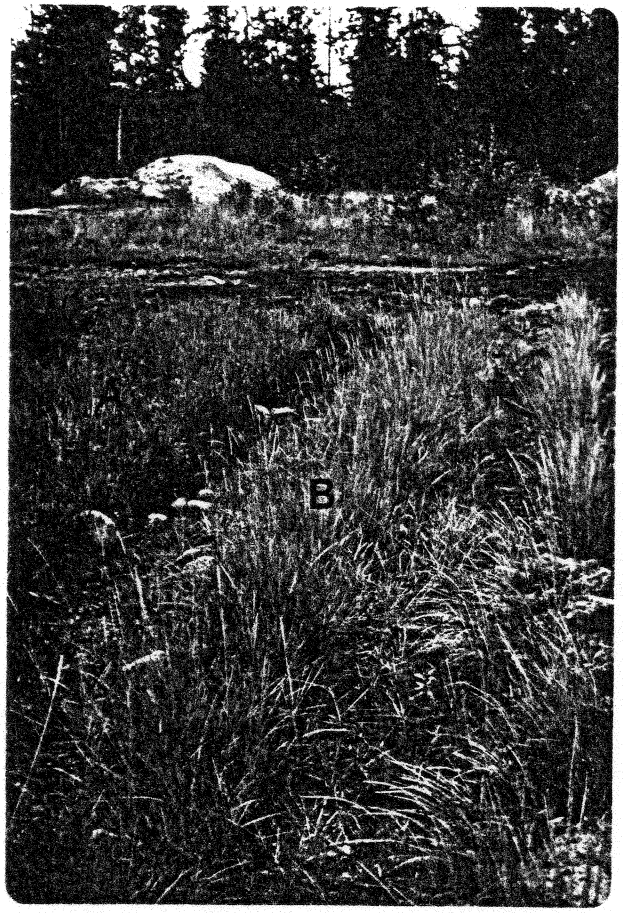

FIGURE 4: A Demonstration of the Vigorous Vegetative Reproduction Growth Since 1977 with Agropyron smithii (B) in the Center and Agropyron repens (A) to the Left of Center.

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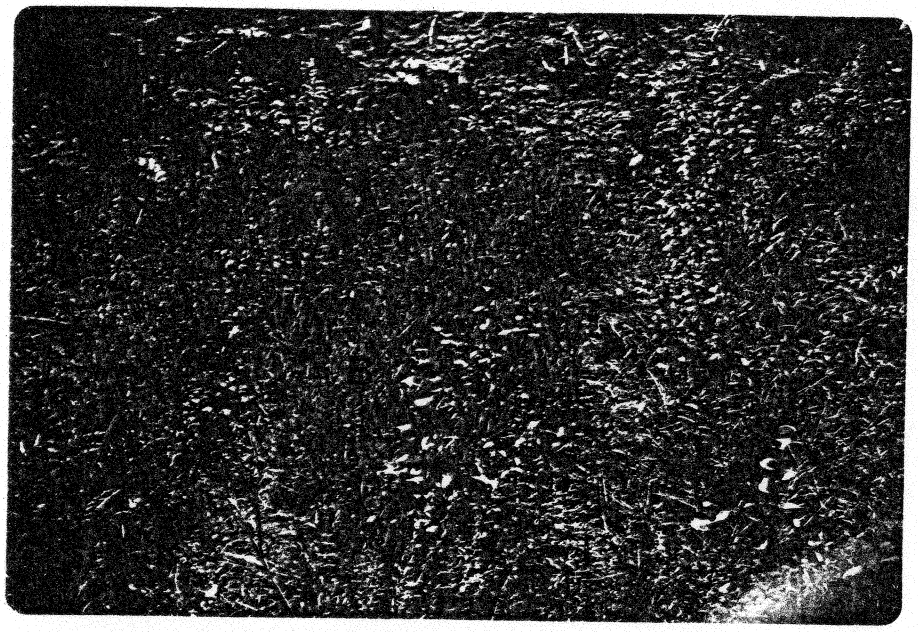

FIGURE 5: Vegetative Reproduction by Bromus pumpellianus (B) in the Center and Bromus inermis (A) to the Left of Center has Filled in the Space Between the Initial Rows.

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TABLE 3: Average vegetative cover, plant height, spread and seed production of transplanted grasses at Fort McMurray when assessed in fall, 1979

(a) Row No.	Species	Stock No.	(b) Percent Cover Class	Average height (cm)	Average rhizomatous spread (cm)	(c) Seed Production class
1	Agropyron cristatum	464	4	32	0	5
2	Agropyron elongatum	465	4	23	0	3
3	Agropyron smithii	46	No Survival			
4	Agropyron smithii	471	2	17	0	2 Not Matured
5	Agropyron spp.	655	No Survival			
6	Agropyron spicatum	656	No Survival			
7	Agropyron subsecundum	658	3	31	0	3
8	Agropyron subsecundum	4	No Survival			
9	Agropyron subsecundum	659	No Survival			
0	Agropyron trachycaulum	660	4	28	0	4
11	Agropyron trachycaulum	662	No Survival			
2	Agrostis gigantea	269	5	17	3	4
13	Agrostis scabra	664	2	13	0	3
4	Agrostis spp.	665	5	17	3	5
15	Agrostis spp.	15	5	17	0	5
16	Agrostis spp.	765	4	20	1	4
7	Agrostis tenuis	297	4	16	0	5
18	Agrostis tenuis	282	4	17	2	4
9	Agrostis tenuis	329	4	16	0	4
20	Arctagrostis spp.	666	2	22	0	2
1	Arctagrostis spp.	667	3	34	0	3
22	Beckmannia syzigachne	355	3	15	0	4
3	Beckmannia syzigachne	498	2	21	0	3
24	Bouteloua gracilis	668	2	25	0	4
5	Calamagrostis spp.	671	4	29	3	5
6	Cinna latifolia	675	2	32	0	4
27	Deschampsia caespitosa	677	4	38	0	5
8	Stipa viridula	554	4	43	0	4
29	Glyceria spp.	691	3	40	0	5

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30	Glyceria spp.	692	4	17	1	5
31	Koeleria cristata	78	3	31	0	4
32	Phalaris arundinacea	696	4	59	2	3
33	Phleum spp.	81	3	41	0	4
34	Poa palustris	628	3	40	0	4
35	Poa pratensis	697	4	41	3	4
36	Poa spp.	769	5	29	0	5
37	Poa spp.	698	5	36	0	5
38	Poa spp.	700	5	28	0	5
39	Poa spp.	701	4	45	2	4
40	Puccinellia nuttalliana	703	3	30	0	5
41	Puccinellia nuttalliana	705	3	27	0	5
42	Trisetum spicatum	407	4	33	0	5
43	Bouteloua gracilis	669	3	32	0	4
44	Danthonia parryi	767	No Survival			
45	Deschampsia spp.	680	3	40	0	3
46	Poa spp.	Unknown	3	45	0	5
47	Stipa comata	713	2	29	0	3

(a) Sample Plot Size 50 cm x 50 cm (= 0.25 m^2)
Rows 1 - 15: 5 sample plots (short rows)
Rows 16 - 47: 15 sample plots (long rows)

(b) Percent Cover Class

1 = 0 - 3%
2 = 3 - 10%
3 = 10 - 25%
4 = 25 - 50%
5 = 50 - 75%
6 = 75 - 100% cover

(c) Seed Production Class

1 = No heads per plot
2 = $\leq$ 10 (few)
3 = 10 - 30
4 = 30 - 50
5 = 50 + (many)

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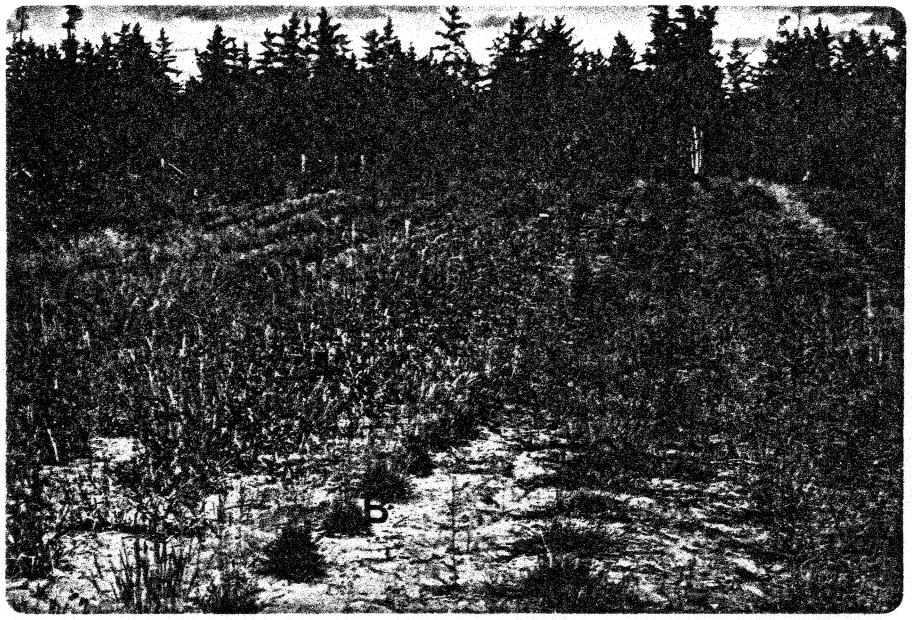

FIGURE 6: View of Some of the Transplanted Grasses on the AOSERP Test Site with Phalaris arundinacea (A) on the Left Followed by Koeleria cristata (B) and Glyceria spp. (C).

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4.3 Fall Seeded Grasses

The trial to evaluate fall seeding of grasses at Fort McMurray can be deemed as successful as survival of fall seeded grasses was reasonably good (Table 4).

Rows one through 14 could not be evaluated as they no longer exist. The species and stock numbers in these rows were: Agropyron spp. (55), Festuca scabrella (26), Poa pratensis (92, 38), Poa spp. (95), Festuca spp. (77), Agropyron subsecundum (4), Festuca altaica (75), Poa ampla (36), Agrostis gigantea (59), Bromus inermis (61, 62), Agropyron smithii (342) and Alopecurus spp. (18).

Deschampsia spp. (67), Festuca rubra (22) and Festuca ovina (21) exhibited the highest percent cover, matured and produced many seed heads (Figure 7).

The average height of vegetative growth ranged from 27 to 47 cm. Agropyron smithii had the tallest growth and Puccinellia nuttalliana was the shortest grass in this group.

4.4 Shrubs and Trees

During the second growing season all shrub and tree species appeared to perform well. Survival of all plants was excellent as all species demonstrated survival rates over 90 percent (Table 5). The average survival rate for the 12 species was 97 percent.

Leader growth within genera was reasonably consistent as shown in Table 5. The two sources of Alnus spp. (557, 558) had leaders of 77 and 68 cm. The differences in leader growth was less between the Potentilla fruticosa sources

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TABLE 4: Average vegetation cover, plant height, spread and seed production of fall seeded grasses at Fort McMurray when assessed in fall, 1979

(a) Row No.	Species	Stock No.	(b) Percent Cover Class	Average height (cm)	Average rhizomatous spread (cm)	(c) Seed Production Class
15	Poa spp.	93	4	37	0	4
16	Deschampsia spp.	67	5	32	0	5
17	Festuca rubra	22	5	39	1	5
18	Puccinellia nuttalliana	276	3	27	0	4
19	Agropyron trachycaulum	10	4	36	0	5
20	Agropyron trachycaulum	286	4	33	0	5
21	Agropyron spp.	41	4	41	0	4
22	Festuca ovina	21	5	35	0	5
23	Agropyron smithii	342	4	47	0	4
24	Poa spp.	Unknown	4	30	0	5

(a) Sample Plot Size 20.4 cm x 73.4 cm (= 0.15 m^2)
Row 15 - 24: 13 sample plots (long rows)

(b) Percent Cover Class

1 = 0 - 3% 2 = 3 - 10%
3 = 10 - 25% 4 = 25 - 50%
5 = 50 - 75% 6 = 75 - 100% Cover

(c) Seed Production Class

1 = 0 No heads per plot 2 = $\leq$ 10 (few)
3 = 10 - 30 4 = 30 - 50
5 = 50 + (many)

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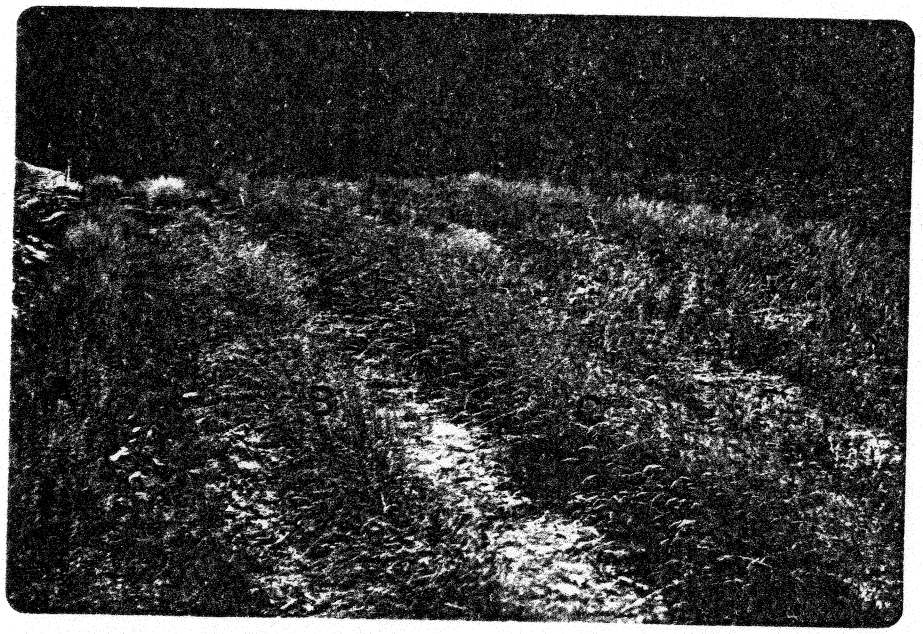

FIGURE 7: Fall Seeding of Grasses can be Successful as Shown here by Poa spp. (A) on the Left Followed by Deschampsia spp. (B), Festuca rubra (C).

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TABLE 5: Evaluation of fall planted shrubs and trees at Fort McMurray after their second growing season

(a) Row No.	Species	Stock No.	Percent Survival %	Height of longest leader (cm)	Average crown diameter (cm)	Flower or Fruit	Average (b) vigor rating	Plants with suckers
25	Betula glandulosa	G.C.O.S.	93	66	40	NO	3.3	0
26	Betula glandulosa	"	100	70	45	NO	3.7	60
27	Betula glandulosa	"	93	68	40	NO	3.5	60
28	Prunus virginiana	144	100	54	53	NO	3.2	93
29	Shepherdia canadensis	186	100	21	22	NO	3.6	0
30	Shepherdia argentea	184	100	30	26	NO	3.5	20
31	Alnus spp.	557	100	77	50	Fruit	3.1	47
32	Alnus spp.	558	100	68	50	Fruit	3.1	47
33	Elaeagnus commutata	134	100	37	30	NO	2.9	40
34	Elaeagnus commutata	135	93	39	30	NO	2.9	7
35	Potentilla fruticosa	139	93	35	50	Flower	3.0	0
36	Potentilla fruticosa	141	93	36	40	Flower	3.1	13
37	Larix siberica	(c) O.P.T.N.	100	55	40	NO	3.7	0
38	Pinus contorta	O.P.T.N.	93	23	20	NO	3.3	0

(a) 15 sample plants were used for all rows except row 29 where every plant (8) was sampled.

(b) Vigor class

1 = poor
2 = fair
3 = good
4 = excellent

(c) Oliver Provincial Tree Nursery

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as well as within the Elaeagnus commutata sources. The Larix siberica plants were putting on good growth as they had an average leader length of 55 cm.

Average crown diameters covered the range from 20 to 53 cm (Table 5). The lowest value for crown spread was recorded for Pinus contorta and the highest value of 53 cm was exhibited by Prunus virginiana. Alnus spp., both source 557 and 558, had crown diameters of 50 cm. These two seed sources also produced fruit in 1979.

As indicated in Table 5, Potentilla fruticosa was flowering, but not fruiting. Because the fruit is very small, it appears to have possibly been overlooked. This species normally produces good seed crops if it flowers. None of the other woody species even produced flowers.

The plants were generally quite vigorous as shown in Table 5. The species were rated as having good to excellent vigor.

Some of the woody species were already producing sprouts. Prunus virginiana exhibited sprouting from 93 percent of the seedlings, while 60 percent of two rows of the Betula glandulosa plants were producing sprouts. Not all species were producing sprouts, but six out of the six shrub genera produced sprouts on one or more of its seed sources (Table 5). As expected, there were no sprouts associated with the two coniferous tree species.

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5. CONCLUSIONS

The initial grass, shrub and tree plot established in 1977 was designed to provide information about plant species adaptable to Fort McMurray conditions. The conclusions presented in the following paragraphs are based on results of an abbreviated 1979 evaluation program.

Spring seeding of grass species on the experimental area was very successful as only two out of the 50 species seeded failed to survive. The failures were Bromus pumpellianus (346) and Poa pratensis (40). The most successful species were: Agropyron spp. (592), Elymus innovatus (294, 331), Deschampsia spp. (66, 67), Festuca rubra (76), Festuca ovina (21), Festuca scabrella (688), Phleum pratense (239), Poa ampla (85), Poa pratensis (305) and Poa spp. (93, 94, 95).

Survival of the transplanted grasses was not as high in this group with seven out of the 47 species failing to survive to the end of the 1979 growing season. Some of the faster spreading and more production seed species were Agrostis spp. (665, 15) and Poa spp. (769, 698, 700).

Fall seeding of grasses appears to be successful as all species assessed survival well. Percent cover was generally good as was seed production.

Tree and shrub species survived well with all rates at 93 percent or higher. All species were exhibiting good to excellent vigor and at least Alnus spp. (557, 558) was producing fruit. Prunus virginiana and Betula glandulosa were producing sprouts on over 50 percent of the plants sampled.

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In conclusion, the selection of plant species for a particular reclamation site depends on having a list of adapted plants with identified growth characteristics and responses. In this report rapid growth has been projected as a highly desirable characteristic. This is true for erosion control, but it may not be desirable if trees or shrubs are to be planted in the grass cover. A slower growing species may be more desirable in the latter situation. Therefore, a more careful consideration of species characteristics should be conducted.

None of the species have been evaluated for biomass production. Germination tests to determine seed viability still have to be conducted. No soil analysis has been done to determine the fertility regime the grasses are growing in. These items should be included in a more thorough evaluation.

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6. RECOMMENDATIONS

The recommendations for this project are outlined in point form below.

- At least one more year of data collection is desirable. It should be initiated much earlier in the year.

- As most seedlots are also present on the nursery plots at the Alberta Environmental Centre in Vegreville, both sets of plots should be maintained and more thoroughly evaluated.

- A common evaluation scheme should be established and utilized on both the Vegreville and Fort McMurray test sites. Items evaluated should include percent cover, seed production, leafy growth height, rate of spread, biomass production, seed viability and soil fertility.

- Sufficient seed should be collected from promising species to permit establishment of additional experimental field trials.

- Small seed collections should be made for retention in storage in the event that some species are slow in showing their potential.

- Preparation of a report summarizing 1980 results should be concluded by December 31, 1980.

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